METHOD AND APPARATUS FOR VIDEO SURVEILLANCE WITH DEFINED ZONES

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of United States provisional patent application serial number 60/188,171 filed on March 10, 2000. United States Patent applications, also claiming the benefit of U.S. Provisional application no. 60/188,171, and entitled "Method and Apparatus for Object Tracking and Detection" and "Method and Apparatus for Object Surveillance with a Movable Camera" were filed concurrently herewith.

FIELD OF THE INVENTION

The present invention relates to the field of video surveillance systems using motion video cameras.

BACKGROUND OF THE INVENTION

There are several shortcomings in current video surveillance systems that need to be overcome for widespread use of automatic detection and collection of relevant video data in response to scene stimulus without the need of a human operator present. When viewing a scene from a video camera a large amount of data is generated. The vast amount of data created produces a data reduction problem. Automatically detecting and accurately and reliably collecting image information of a moving object using a motion video camera is a difficult task. This task is made even more difficult when trying to detect, track and maintain camera line-of-sight using a single motion video camera without requiring human intervention.

U.S. Patent 5,473,369 (Abe) describes the use of a camera to detect and track a moving object without using conventional block matching. In the system described in Abe single object tracking is performed only after an object is placed within a frame on a screen; however, there is no user input device for manual target selection Moreover, Abe does not provide for camera movement to maintain line-of-site.

Other prior art solutions provide for image stabilization for a camera in arbitrary motion without object tracking functionality. U.S. Patent 5,629,988 (Burt) teaches electronic stabilization of a sequence of images with respect to one another but provides no tracking facility.

Still other prior art solutions control camera movement to maintain line-of-sight between camera and object but lack arbitrary motion compensation or do not provide for automatic and user selected object tracking. U.S. Patent 5,434,621 (Yu) teaches a method for automatic zooming and automatic tracking of an object using a zoom lens but does not provide for reorienting the camera's line-of-sight.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a video surveillance method and system having increased accuracy.

It is an object of the present invention to provide a method and system for reducing false alarms in motion video object detection and surveillance.

It is an object of the present invention to provide a method and system for identifying user-defined zones to control motion video tracking.

In accordance with one aspect of the present invention there is provided a method for defining a control zone in a field of view of a motion video camera, said method comprising the steps of: displaying motion video data representative of the field of view of the motion video camera; receiving indication of a control zone type; and receiving indication of a control zone size within the field of view of the motion video camera.

In accordance with another aspect of the present invention there is provided a system for defining control zones of different types in a field of view of a motion video camera, said system comprising: a database containing a description for each of a plurality of control zone types; means for defining a control zone in a selected area of the field of view of the motion video camera, said control zone being of a type selected from one of said plurality of control zone types in said database; and means for displaying a received motion video signal from the motion video camera including an indication of said defined control zone.

In accordance with a further aspect of the present invention there is provided a computer readable medium having stored thereon computer-executable instructions for defining a control zone in a field of view of a motion video camera performing the steps comprising: displaying motion video data representative of the field of view of the motion video camera; receiving indication of a control zone type; and receiving indication of a control zone size within the field of view of the motion video camera.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an exemplary configuration of a video surveillance system having user-defined zones according to an embodiment of the present invention;

Figure 2 shows an exemplary field of view for a camera highlighting user-defined zones according to the present invention;

Figure 3 is a system diagram of a zone defining processing system the video surveillance system of Figure 1 according to an embodiment of the present invention;

Figure 4 is a flow chart illustrating a method of identifying user-defined zones according to the present invention; and

Figure 5 is a flow chart illustrating a general method for video surveillance using the user-defined zones identified by the method in Figure 4.

DETAILED DESCRIPTION

Object tracks, derived from motion video data, are a very useful way to automatically detect alarm conditions within a camera's field of view for purposes such as security and surveillance. However, in the field of motion video object tracking, environmental noise and other such sources of movement can lead to false tracking and tracking of unimportant objects such as leaves falling from a tree.

The present invention uses user-defined regions within a motion video camera's field of view to ignore the origination of object track data but allow tracking of objects already being tracked before they entered that region. Therefore, the user defines in advance those regions that may generate false alarms within a motion video camera's field of view. The use of user-defined zones in conjunction with object detection and tracking techniques provides a video surveillance system that has greater object tracking accuracy than existing systems.

Figure 1 illustrates a video surveillance system 100 according to an embodiment of the present invention. A motion video camera 108 has a field of view 118. A computer 102 receives and processes a video signal 112 from the motion video camera 108 and performs object tracking and detection to determine if there was movement in the field of view 118. The computer 102 contains a zone defining processing system (Figure 3) for defining surveillance zones in the camera's 108 field of view.

For a moveable motion video camera 108, the computer 102 generates a control signal 114 for servo controlled pan-tilt-zoom assembly 110. The control signal 114 is based on the current position of the servo controlled pan-tilt-zoom assembly 110 and information

contained in the video signal 112. Such movement allows the motion video camera 108 to capture an object of interest in greater detail or improve the camera's 108 line of sight with the object of interest. The object detection and tracking techniques that are used can be, for example, those taught in Applicant's related applications entitled "Method and Apparatus for Object Tracking and Detection" and "Method and Apparatus for Remote Object Tracking and Detection", filed concurrently herewith, both of which are incorporated herein by reference.

Object detection may be accomplished using any number of methods for image segmentation known in the art. For example, motion detection may be performed by frame differencing sequential pairs of video frames and applying thresholding techniques thereby yielding pixels within the processed image that reflect motion of objects with the field of view of the camera 108. Additional image processing techniques such as centroid analysis may then be applied to remove spurious motion. Kalman filtering may be applied over time to further remove random motion and to estimate motion of objects for the purpose of anticipating camera 108 repositioning and maintaining tracking when moving objects are temporarily occluded by stationary ones. Object tracking and detection is discussed in greater detail in applicant's co-pending related applications entitled "Method and Apparatus for Object Tracking and Detection" and "Method and Apparatus for Object Surveillance with a Movable Camera" filed concurrently herewith and incorporated herein by reference.

For a fixed motion video camera 108 (not shown) not having a servo controlled pan-tilt-zoom assembly 110, the computer 102 uses the video signal and the current magnification of the camera 108 to create a control signal similar to the control signal of the moveable camera 114. However, the control signal for a fixed camera only uses a zoom function already on the camera 108 to capture the object of interest in greater detail.

The video signal 112 received from video camera 108 is passed out from the computer 102 as video signal out 106 either directly to a display 104 or modified to include graphic information that may be used to set up response parameters of a tracking program, indicate an object that is actively being tracked or identify (or allow identification of) user-defined zones for tracking. A pointing device 116 may be a mouse or trackball and is the user input for modifying said response parameters or defining the tracking zones. The pointing device 116 may also be used by the user to select an object that appears within the field of view 118 such that tracking program residing on the computer 102 acknowledges user's selection and initiates tracking of the selected object.

Figure 2 is an illustration of an exemplary field of view 200 for a camera highlighting user-defined zones according to the present invention. In this illustration, the environment that the motion video camera 108 is receiving within its field of view 200 is shown. For the purpose of illustration, the environment contains a house 220, a tree 230, a walkway 240, and a pond 250. There are five different types of zones 202, 204, 206, 208, and 210 that control tracking behavior and subsequent video output. These zones are defined as follows:

Zones	**Definition**	**Application**
Tracking Zone	Sets the overall surveillance region defining pan and tilt limits of camera. The tracker does not track nor does it move the camera beyond the tracking zone.	Include only the region in which tracking is required.
Black-out Zone	Sets regions within the tracking zone in which tracker will not track. The tracker does not track any target that moves into a black-out zone, nor does it originate a target within a blackout zone.	Reflections, high traffic areas, machinery, other unwanted distractions.
Exclusion Zone	Sets regions within the tracking zone in which tracker will not originate a new track but that tracked objects may enter and exit. The tracker maintains a track that enters an exclusion zone.	Trees, machinery, water and other stationary reflective surfaces.
Entry Zone	Sets region within the tracking zone in which tracker will automatically originate a new track and follow. When the tracker is programmed to search only the entry zone, then this is the only region in which tracks can originate.	Watch doors, windows, vehicles and other assets.

Privacy Zones	Sets regions in the tracking zone not viewable by the operator. The tracker maintains tracking passing into and out of privacy zones.	Areas within tracker field of view but requiring privacy from camera such as office windows and homes.

The tracking zone 208 is shown on the display encompassing the house 220, the tree 230, the walkway 240, and the pond 250. Only for the purpose of illustration is the tracking zone 208 contained within a single field of view 118. For embodiments using a moveable camera 108, the tracking zone 208 may span several fields of view. An exclusion zone 250 is shown encompassing that portion of the pond 250 that is within the tracking zone 208. A black-out zone 202 is shown encompassing the leafy portion of the tree 230 which may generate tracking events when the leaves move in the wind. Since in this field of view 200, it is not anticipated that tracks will not enter into the perimeter, the entire region receives a black-out zone 202 rather than an exclusion zone 204. An entry zone 206 is shown encompassing the door of the house 220. A privacy zone 210 is shown encompassing the window of the house 220.

Figure 3 is a zone defining processing system 120 for defining surveillance zones in the camera's 108 field of view according to an embodiment of the present invention. The zone defining processing system 120 has a field of view (FOV) area definer 132 that connects interfaces to various devices (i.e. camera 108, input device 116, and display 104), a zone type database 128 and a tracking/monitoring controller 130. A camera interface 122 receives the video signal in from the motion video camera 108 and passes this signal to the FOV area definer 132. The FOV area definer 132 can pass this signal directly to a display interface 126 to be shown on the display 106 or the signal may be modified to include a graphic overlay containing information on zones within the field of view.

The FOV area definer 132 may send a zone type selection menu to the display interface 126 to prompt a user to select a zone type using the input device 116. The zone type database 128 contains definitions for the different types of zones as well as corresponding actions for each zone type (i.e. do not initiate tracking objects but continue following previous tracks). Indication of a selected zone type is received at a input device interface 124.

After a zone type has been selected the FOV area definer 132 provides the display interface 126 with a graphic overlay for the field of view to assist the user in drawing a zone of the selected type. After an indication of a drawn zone has been received through the input device interface 124, the FOV area definer 132 provides the display interface 126 with a graphic overlay indicating the defined zone.

The tracking/monitoring controller 130 tracks and monitors defined objects within the field of view. Given a field of view the tracking/monitoring controller 130 consults the FOV area definer 132 to determine a mapping between defined zones and the field of view. The FOV area definer 132 provides the tracking/monitoring controller 130 with the mapping between defined zones and the field of view as well as a definition of the zone types and the corresponding actions for each zone type.

Figure 4 is a flow chart illustrating a method 300 of identifying user-defined zones according to the present invention. All of these zones are shown on the display 104 as graphic overlays to the video signal in 112 received from the camera 108 in step 302. An input device such as a mouse 116 is provided for selecting a zone type in step 304. The type of zone may be selected, for example, from a menu listing all zone types or applicable zone types given other settings. These zones may be selected and resized in step 306 by a user with a mouse 116 or similar pointing device by holding down a mouse button and moving the mouse 116 to resize a rectangular region over some portion of the display's image. If the extent of a rectangular region exceeds a single field of view, the mouse 116 is moved to any of the four edges or corners of the display which results in the tracking program residing on the computer 102 sending control signal 114 to the pan-tilt-zoom assembly 110 resulting in an altered field of view. The mouse button is released when the desired region is encompassed by a rectangle. After the size of the zone has been drawn in step 306, the method 300 is repeated for multiple instances of zones of a single type, as applicable, as for other types of zones. Multiple overlapping and non overlapping shapes may be used to define more complex zones. Once these regions are defined, the tracker performs in its environment according to the rules that are defined for each type of region.

Fig. 5 is a flow chart illustrating a general method 400 for video surveillance using the user-defined zones identified by the method 300 in Figure 4. The video surveillance system continuously monitors a tracking zone (except for any black-out zones) in the field of view for movement 402. When movement is detected 404 subsequent video frames are compared 406 to determine what zone the movement occurred in 408. If the movement is not in a

black-out zone or exclusion zone the object is isolated 410 and tracking starts 412. If the movement is in a black-out zone or exclusion zone tracking is not initiated and the video surveillance system continues to monitor the tracking zone for movement 402. While an object is being tracked if it leaves the current field of view and enters a new field of view 414 the camera 108 may be moved 418 to center the tracked object in the camera's 108 field of view. Movement of the camera 108 to maintain a moving object in the field of view is discussed in more detail in applicant's co-pending application related applications entitled "Method and Apparatus for Object Surveillance with a Movable Camera" filed concurrently herewith and incorporated herein by reference. If the object enters a black-out zone or exits the tracking zone 416 then tracking stops and the system continues to monitor the tracking zone for movement 402. If the object has not entered a black-out zone or exited the tracking zone then the object continues to be tracked.

If movement is not detected in step 404 then the camera 108 is moved to the next field of view 403 to continue searching for movement 402.

It is apparent to one skilled in the art that numerous modifications and departures from the specific embodiments described herein may be made without departing from the spirit and scope of the invention.